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(54) Method and apparatus for spraying powdered material using pulsating vibration air

(57) Spray and method for spraying powdered material activated by pulsating vibration air. The spray comprises an elastic membrane (3), a tank (2) for storing powdered material provided with the elastic membrane (3) at the bottom opening (2a), and a pulsating vibration air generating means (4) for supplying pulsating vibration air to the elastic membrane (3). The spray such constructed is designed to uniformly and diffusely spray the powdered material stored in the tank (2) when the elastic membrane (3) is forcedly vibrated up and down in compliance with the frequency of the pulsating vibration air by receiving pulsating vibration air from the pulsating vibration air generating means (4).

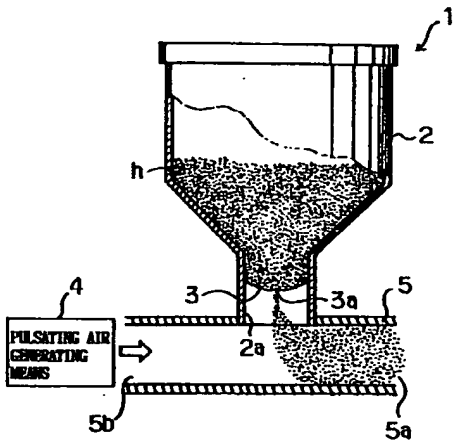

Fig.1

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Description

BACKGROUND OF THE INVENTION

This invention relates to a newly developed spray and method for spraying powdered material in extremely small quantity activated by pulsating vibration air and more particularly to a spray for spraying bulky and soft powdered material with large specific volume or powdered material with bad fluidity without causing clogging.

II. Prior Art

Manufacturing of tablet is generally comprised of weighing, mixing, granulation, tableting and inspection process. A trace of additive which is described in a statement of the powers of medicine is added to the basis of the medicine in the process of mixing or tableting.

The applicant of the present invention has proposed and disclosed a spray means for effectively spraying powdered material in extremely small quantity in Japanese Patent Application H6-10187 (filed on Feb. 1, 1994).

The spray means as formerly proposed by the applicant is provided with a storage tank a with a valve f at the bottom end in which powdered material h is stored as shown in Fig. 7. The spray means is also provided with a reservoir c which has a body for storing powdered material h and a filter cloth b formed with at least plural bores g at the tip end and a gas feeding means d.

According to the spray means such constructed, powdered material h can be continuously sprayed through the bores g when the filter cloth b of the reservoir c is forcedly vibrated by a vibrator e while driving gas is fed into a communication pipe i from the gas feeding means d.

SUMMARY OF THE INVENTION

However in such a spray means, bulky and soft powdered material with large specific volume in which the ratio of air to powder is rather-large or the powdered material with bad fluidity cannot be sprayed for a long period without causing clogging since such powdered material stored in the reservoir c would be caught in the bores g of the filter cloth b while the spray is repeatedly used. Namely, clogging trouble has been often caused in such constructed spray means. Further, it needs considerable time that the powdered material thus attached to the filter cloth b has amounted to be constant quantity and spray amount per unit time becomes constant.

The present invention has been proposed to solve the above-mentioned problems. Accordingly, the primary object of the invention is to provide a spray for spraying powdered material activated by pulsating vibration air with simple construction wherein even bulky and soft powdered material with large specific volume in which the ratio of air to powder is rather large or the powdered material with bad fluidity can be sprayed quantitatively and continuously without causing clogging and a method for spraying powdered material using the spray of the present invention.

According to the spray for spraying powdered material activated by pulsating vibration air in the present invention referred in claim 1, the spray comprises an elastic membrane formed an opening, a tank for storing powdered material provided with the elastic membrane at the bottom opening, and a pulsating vibration air generating means for supplying pulsating vibration air to the elastic membrane. The spray such constructed is designed to uniformly and diffusely spray powdered material stored in the tank from the opening of the elastic membrane when the elastic membrane is forcedly vibrated up and down when receiving pulsating vibration air from the pulsating vibration air generating means.

According to the spray of the present invention referred in claim 2, the opening of the elastic membrane is a cut opening and is formed at the center of the elastic membrane.

According to the spray of the present invention referred in claim 3, the opening of the elastic membrane is comprised of plural little bores with various shapes or almost equal shape.

The applicant also proposes a separate spray of the present invention referred in claim 4, in which a communication pipe communicating with the bottom opening of the tank is further provided and has at one end an injection port and at the other end a connecting port to the pulsating vibration air generating means. The elastic membrane is forcedly vibrated up and down to make the opening of the elastic membrane open and close when the pulsating vibration air generating means is activated so that the powdered material is uniformly and diffusely sprayed from the injection port.

The applicant still further proposes a spray for spraying powdered material in which its application is specified for spraying lubricant on medical tablets when they are manufactured.

In claims 6 - 9, the applicant of the present invention proposes a spraying method to use the present spray as set forth in claims 1 - 5 by utilizing its advantages.

In such present invention as proposed by the applicant, there is no trouble of causing cross contamination since the spray is provided with no mechanical driving means like a vibrator. And there is no trouble of causing clogging since the cut opening or the little bores respectively formed in the elastic membrane opens in such a manner that the opening

or the bores are deformed to widely open only when emitting the powdered material stored in the tank. In addition, there is no trouble of remain nor inclination of the powdered material stored in the tank since the elastic membrane itself which constitutes a bottom of the tank is vibrated up and down so as to emit all the powdered material stored in the tank.

Also in such a present invention, some advantages are as follows. Namely, one of the advantages of the present invention is that controlling of the amount of spraying is very easy and accurate by only controlling the application of pulsating vibration air. And the other advantage is that soft powdered material with large specific volume in which the ratio of air to powder is relatively large or the powdered material with bad fluidity can be uniformly and quantitatively sprayed without causing clogging by applying pulsating vibration air which has vibration energy to move the elastic membrane up and down in relatively large quantity.

Further according to the present invention, cleaning is not required and maintenance is easy because the filter cloth which has been used in the prior spray isn't necessary. Furthermore, in such present invention, the construction of the spray can be more simplified because vibration means like a vibrator isn't necessary at all. Still further in such a present invention, even liquid-like or slurry material can be stored in the tank for spraying.

On the contrary in the prior art, as far as the inventors know, liquid-like material could not be continuously sprayed without causing clogging due to the leakage of material from the filter cloth provided with the tank.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a vertical sectional view of a spray for spraying powdered material activated by pulsating vibration air according to the invention.

Fig. 2 is a plan view of one embodiment of an elastic membrane. (claim 2)

Figs. 3 (a) - (c) show how the elastic membrane is operated when receiving pulsating vibration air.

Fig. 4 is a plan view of a separate embodiment of an elastic membrane. (claim 3)

Fig. 5 shows one example of spray for spraying lubricant activated by pulsating vibration air according to the present invention.

Fig. 6 is an enlarged vertical sectional view of "X" in Fig. 5.

Fig. 7 is a front view, partially in section, of the prior art of the spray means for spraying powdered material.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Preferred embodiment of the present invention will be described referring to the drawings.

Fig. 1 shows construction of a spray with a tank for storing powdered material according to the present invention. Fig. 2 is a plan view of an elastic membrane with a cut opening and Figs. 3 (a) - (c) show how the elastic membrane works when pulsating vibration air is supplied.

As seen from the drawings, a tank 2 is formed with a narrowed bottom and has a storage body for storing powdered material h. And the storage body has a bottom opening 2a which is provided with an elastic membrane 3 formed a cut opening 3a in the center. The elastic membrane 3 is preferably made of soft thin Teflon plate or thin silicon plate and has the cut opening 3a which may be formed by using a sharp edged tool such as a razor. The size of the cut opening 3a is appropriately defined in accordance with the particle diameter of powdered material to be sprayed. The applicant has perceived that 2mm - 3mm diameter in the size of the cut opening 3a is preferable when particle diameter is 250 μm and spray amount per unit time is about 1g/minutes.

Pulsating vibration air is fed from a pulsating vibration air generating means 4 provided at one end 5b of a communication pipe 5 and is supplied into the elastic membrane 3 from downward. The communication pipe 5 is provided at one end with an injection port 5a provided for spraying. Wave height and frequency of pulsating vibration air should be defined according to the physical property of powdered material h to be sprayed and the elastic membrane 3. As to the value of the frequency of pulsating vibration air, relatively low value should be set in order to give large vibration to the elastic membrane 3. For example, frequency from 10Hz to 40Hz will be preferable. According to such constructed spray 1, the elastic membrane 3 is forcedly vibrated up and down in compliance with the frequency of the pulsating vibration air when the elastic membrane 3 receives pulsating vibration air, and in the mean time the periphery of the membrane 3 is deformed to make a node and whereas the center part around the cut opening 3a is deformed to make an antinode as shown in Fig. 3(a) and Fig. 3(c).

Fig. 3 shows more clearly how the elastic membrane 3 works at this time, namely when the elastic membrane 3 receives the pulsating vibration air. As shown in Fig. 3(a), when the elastic membrane 3 is elastically deformed like it is lifted up, the cut opening 3a is widened in the upper end and is closed in the bottom end so that the cut opening 3a is deformed to open in V-shaped form. Namely, the cut opening 3a opens in such a manner that the cut end facing to the inner side of the tank 2 is widened and the other cut end facing to the inner side of the communication pipe 5 is closed. As the result, the powdered material h stored in the tank 2 easily enters into the V-shaped cut opening 3a. And then the elastic membrane 3 is elastically deformed like it is pushed down as shown in Fig. 3(c) after the elastic membrane 3

returns to a neutral position where the powdered material stuck in the cut opening 3a is once tightly held in the cut opening 3a as shown in Fig. 3(b) and in the mean time the cut opening 3a is widened in the bottom end and is closed in the upper end so that the cut opening 3a is deformed to open in versa V-shaped form as shown in Fig. 3(c). As the result, powdered material held in the cut opening 3a is energetically emitted from the versa V-shaped cut opening 3a. According to the spray of the present invention, the powdered material stored in the tank 2 can be accurately sprayed from the injection port 5a in compliance with the frequency of the pulsating vibration air while the elastic membrane 3 receives pulsating vibration air via the communication pipe 5 from the pulsating vibration air generating means 4.

In other words, according to the spray 1 of the present invention, the elastic membrane 3 can be vibrated up and down to make an antinode and a node in a well known manner like oscillation technology so that the cut opening 3a repeatedly holds and emits powdered material h stored in the tank 2 every time the cut opening 3a opens and closes by receiving pulsating vibration air. As the result of such operation of the membrane 3, even liquid-like or slurry powdered material stored in the tank 2 can be uniformly and diffusely sprayed from the cut opening 3a without causing clogging.

Therefore, spray amount of the powdered material can be accurately controlled by varying the frequency of the wave height of the pulsating vibration air. Further, bulky and soft powdered material with large specific volume in which the ratio of air to powder is rather large, even liquid-like material or slurry material can be quantitatively and continuously sprayed without causing clogging.

In the above-mentioned embodiment, the cut-opening is formed at the center of the elastic membrane, but plurality of bores may be formed around the center thereof.

Fig. 4 is a plan view of an elastic membrane 3 with plural little bores 3b. This elastic membrane 3 is attached to the bottom opening 2a of the tank 2 like the above-mentioned embodiment. The plural little bores 3b are made by punching all around the center and the surface of the elastic membrane 3. The bores may be made in various shapes or almost equal shape. When pulsating vibration air is supplied from the bottom of the tank 2, the elastic membrane 3 is forcedly vibrated up and down in compliance with the frequency of the pulsating vibration air, while the center of the elastic membrane 3 is deformed to make an antinode and the periphery of the elastic membrane 3 is deformed to make a node like an above-mentioned manner.

In the above-mentioned embodiment, the size of the bores of the elastic membrane is almost the same but the size may be differed.

In this embodiment, powdered material h can be emitted quantitatively and continuously in extremely small quantity through the bores 3b without causing clogging. Accordingly, spray amount of the powdered material stored in the tank 2 can be accurately controlled even in extremely small quantity by varying the frequency or the wave height of the pulsating vibration air. And further, even liquid-like material or slurry material can be emitted through the bores 3b quantitatively and continuously without causing clogging. In this embodiment, the diameter of the bores 3b should be defined so preferable as not to drop the powdered material through the bores 3b when the pulsating vibration air is not supplied, namely when the elastic membrane 3 is at a standstill. For example, the diameter of the bores 3b will be preferably defined as 0.5 mm or so. According to this embodiment, it is more suited for quantitatively spraying powdered material in relatively large quantity in which the size of the particle is relatively large compared with the above-mentioned embodiment, namely the spray having the elastic membrane 3 with the cut opening 3a.

Fig. 5 and Fig. 6 show other example of a spray for continuously supplying lubricant to a tableting machine when medical tablets are manufactured. Such a spray A is used for spraying lubricant on a die and a punch of a tableting machine. An elastic membrane 3 is provided at the bottom of a lubricant hopper 2 with a supply valve 21 thereunder. A diffusing chamber 6 is further provided under the valve 21 and is connected with an air conduit 10 connecting to a pulsating vibration air generator 7 and a spray conduit 11 for feeding lubricant to the tableting machine. The pulsating vibration air generator 7 is connected with an air supply source 8 such as a compressor via a flow control means 9, whereby transport air supplied from the air supply source 8 is fed together with pulsating vibration air to the diffusing chamber 6 through the air conduit 10.

According to the above-mentioned construction, when only the air supply source 8 is driven, the elastic membrane 3 may not be vibrated up and down. Therefore, transport air fed to the diffusing chamber 6 from the air supply source 8 is supplied to the tableting machine through the spray conduit 11 so that powdered material remained in the diffusing chamber 6 or attached on a part of the tableting machine can be blown and cleaned. In this case, when the supply valve 21 of the lubricant hopper 2 is closed, the lubricant h would not fall into the diffusing chamber 6 even if the transport pressure of the transport air introduced from the air supply source 8 to the diffusing chamber 6 is increased. As the result, drying and cleaning of the spray by means of highly pressurized air may be possible.

However, when the pulsating vibration air generator 7 is driven in addition to the air supply source 8, the elastic membrane 3 vibrates up and down since the transport air has vibration energy enough to vibrate the elastic membrane 3. Then, the lubricant h falls in the diffusing chamber 6 continuously to be sprayed therein and the sprayed lubricant h can be fed to the tableting machine through the spray conduit 11 following the flow of the transport air.

[Experiment]

One example of the experiment executed by the present inventors will be explained hereinafter.

The value of the spray amount per minute (mg/min) and the value of the CV (coefficient of variation) of the sprayed material obtained from the experiment are as described in Table 1 where the number or the positioning of each cut opening and bores are varied, and stearin acid magnesium with average diameter of 10 μm which may be used for lubricant as the powdered material to be sprayed and an elastic membrane with 38 μm in diameter and 1.0mm in thickness are employed. In this case, pulsating vibration air with 20Hz frequency and 0.2 MPa pressure is also employed.

The result is as follows;

Table 1

Kind of Bore	Number	Position	Amount(mg/min)	CV(%)
Sample 1 cut opening (2mm slit)	1	center	800	3-4
Sample 2 little bore (Ø 0.5mm)	1	center	300	12-15
Sample 3 little bores (Ø 0.5mm)	5	around the center	1000	10-15

As seen from the Table 1, it should be noted that the CV of sample 1 with a cut opening is smaller than the sample 2 or 3 comparing with each sample, namely the former is one forth or one fifth of the latter and the spraying amount of the former is also stabler than that of the latter. It is assumed that it depends on the fact sample 1 with a cut opening is larger in deforming rate than sample 2 or 3 with bores and therefore it rarely causes plug up or clogging trouble in sample 1. The table also shows that the more the bores increases in number, the larger the amount of the spraying is, however the amount of the spraying is not proportional to the number of the bores. From the view of the applicant's analysis, it is also assumed that the oscillation amplitude of the elastic membrane becomes larger in the part near the center and smaller in the part further departing from the center so that the opening rate of the bores also becomes smaller in the part further departing from the center than in the part near center. And it has been confirmed by the experiment that the spraying amount decreases when the cut opening is shiftedly made in the part departing from the center of the elastic membrane.

It should be also noted that the diameter of the little bores formed in the elastic membrane is dependently defined upon that the bores don't allow the powdered material to drop out of the bores when pulsating vibration air is not applied and it depends on the physical characteristics of the powdered material to be sprayed. In the experiment executed by the applicant in which stearin acid magnesium is used as the powdered material to be sprayed, the elastic membrane with bores whose diameter is maximumly 1.0mm are employed.

According to the spray means of the present invention wherein such an elastic membrane is used as an injection valve, the elastic membrane is once expanded at the beginning of air supply when steady flow is supplied to the elastic membrane. However, the deformation of the elastic membrane doesn't appear. The powdered material drops out of the opening or bores of the elastic membrane but it doesn't occur continuously because the elastic membrane keeps its expanded shape. However, when pulsating vibration air is supplied, the elastic membrane vibrates up and down regularly according to the frequency of pulsating vibration air as mentioned above. In this case continuous and quantitative cut-out operation is generated so that powdered material stored over the elastic membrane is continuously sprayed out of the bores to under the elastic membrane. Therefore, the spray amount of powdered material can be accurately controlled by varying the number of bores, the position of bores or cut opening, and the frequency of pulsating vibration air.

The elastic membrane with the cut opening at the center thereof can execute the most accurate control as mentioned above.

Claims

1. A spray apparatus for spraying powdered material activated by pulsating vibration air, characterized in that the spray apparatus comprises:

   - an elastic membrane (3) with an opening (3a, 3b),
   - a tank (2) for storing powdered material (h) provided with the elastic membrane (3) at the bottom opening (2a) thereof, and
   - pulsating vibration air generating means (4) for supplying pulsating vibration air to the elastic membrane (3), whereby the elastic membrane (3) is forcedly vibrated up and down by receiving the pulsating vibration air so that the powdered material (h) is uniformly and diffusely sprayed.

2. The apparatus according to claim 1,
characterized in that
the opening of the elastic membrane (3) is a cut opening (3a) formed at the centre of the elastic membrane (3).

3. The apparatus according to claim 1,
characterized in that
the opening of the elastic membrane (3) comprises a plurality of little bores (3b) with various shapes or almost equal shape.

4. The apparatus according to any of claims 1 to 3,
characterized in that
the spray apparatus further comprises

a communication pipe (5) communicating with the bottom opening (2a) of the tank (2) which pipe (5) has at one end an injection port (5a) and at the other end a connecting port (5b) connected with the pulsating vibration air generating means (4),
whereby the elastic membrane (3) is forcedly vibrated up and down when the pulsating vibration air generating means (4) is activated so that the powdered material (h) is uniformly and diffusely sprayed from the injection port (5a).

5. The apparatus according to any of claims 1 to 4,
characterized in that
the powdered material (h) is a lubricant to be sprayed on medical tablets in the process of manufacturing medical tablets.

6. A method for spraying powdered material activated by pulsating vibration air, using a spray apparatus which comprises an elastic membrane (3) with an opening (3a, 3b), a tank (2) for storing powdered material provided with the elastic membrane (3) at the bottom opening (2a) thereof, and pulsating vibration air generating means (4) for supplying pulsating vibration air,
characterized in that the method comprises the following steps

- filling the tank (2) with powdered material (h), and
- applying the pulsating vibration air to the elastic membrane (3) of the tank (2) from downward so as to forcedly vibrate the elastic membrane (3) up and down whereby the powdered material (h) stored in the tank (2) is continuously, uniformly and diffusely discharged from the opening (3a, 3b) of the elastic membrane (3) in accordance with the frequency of the pulsating vibration air.

7. The method according to claim 6,
characterized in that
the opening of the elastic membrane (3) is a cut opening (3a) formed at the centre of the elastic membrane (3).

8. The method according to claim 6,
characterized in that
the opening of the elastic membrane (3) comprises a plurality of little bores (3b) with various shapes or almost equal shape.

9. The method according to any of claims 6 to 8,
characterized in that
the powdered material (h) is a lubricant to be sprayed on medical tablets in the process of manufacturing medical tablets.

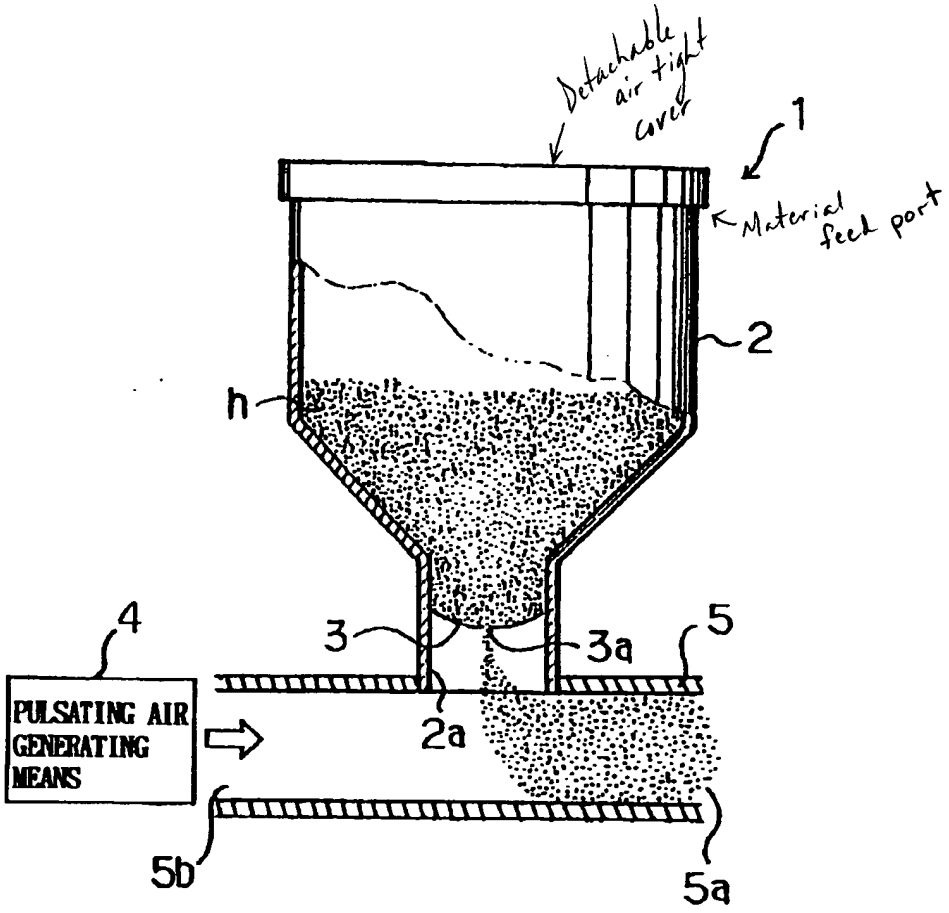
Detachable air tight cover
1
Material feed port
2
h
4
3
3a
5
PULSATING AIR GENERATING MEANS
2a
5b
5a

Fig.1

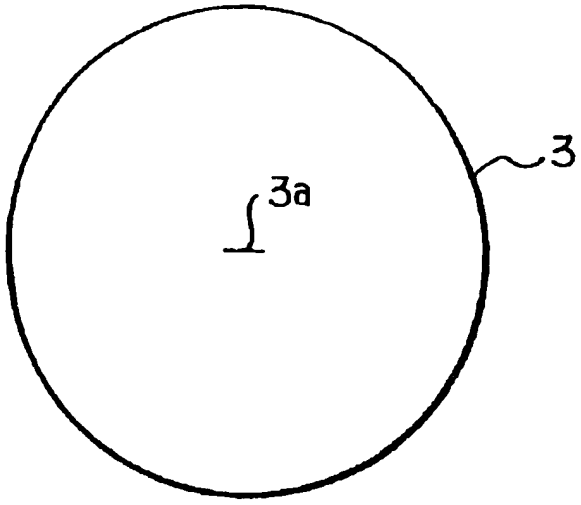
3
3a

Fig.2

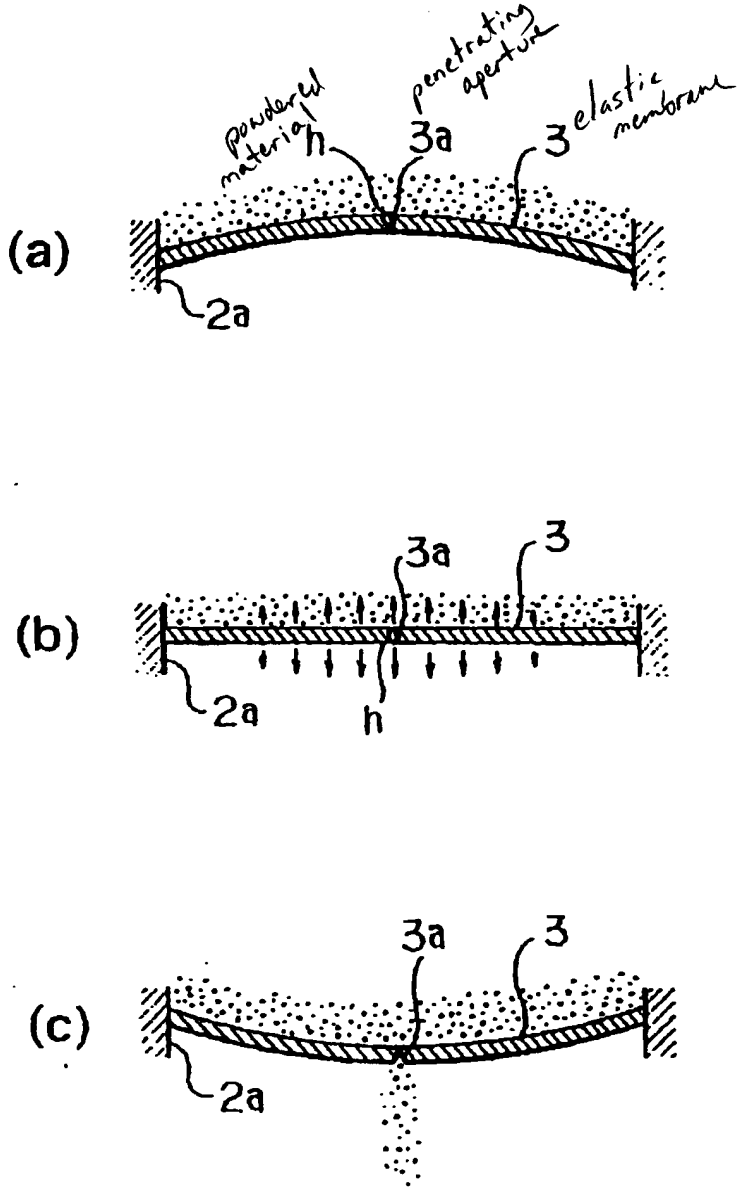
(a)
powdered material
h
penetrating aperture
3a
3
elastic membrane
2a
(b)
3a
3
2a
h
(c)
3a
3
2a

Fig.3

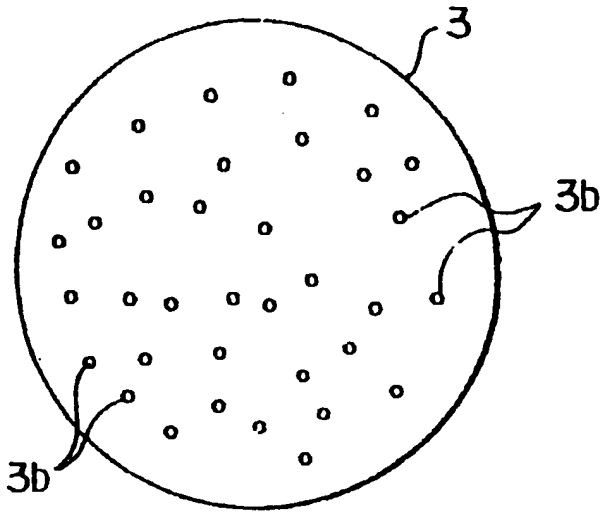

Fig.4

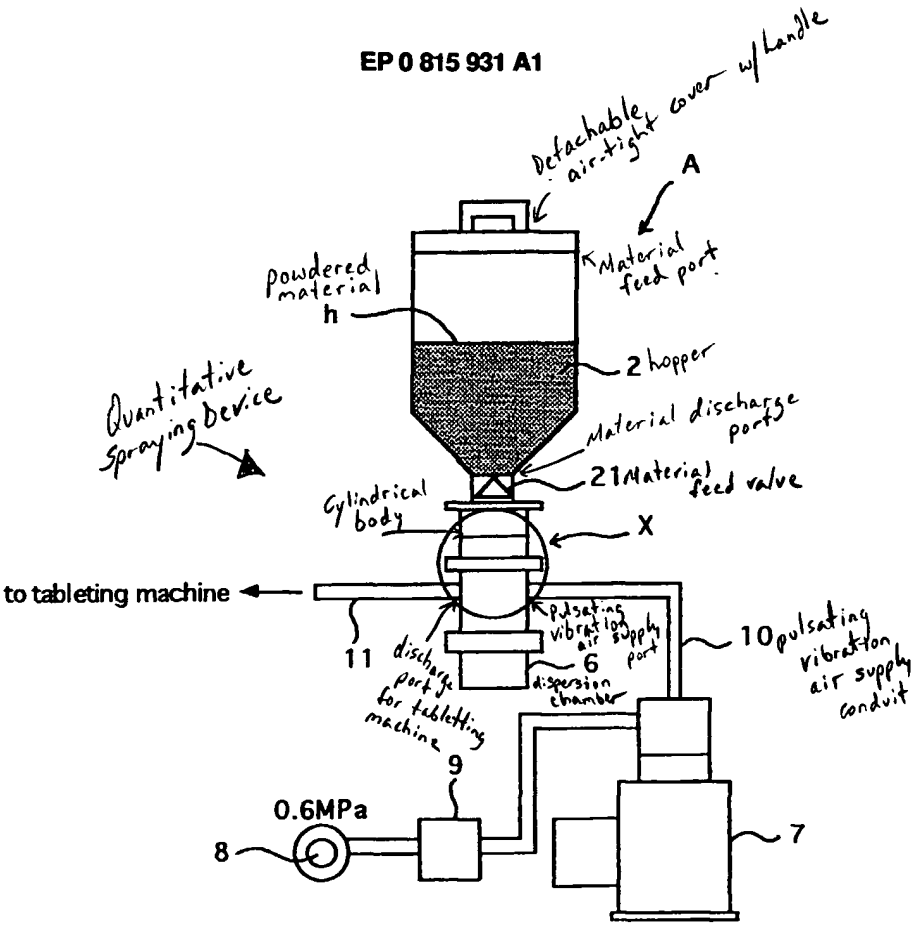
Detachable air-tight cover w/ handle
A
Material feed port
Powdered material
h
2 hopper
Quantitative spraying device
Material discharge portge
21 Material feed valve
Cylindrical body
X
to tableting machine
11
discharge port for tabletting machine
Pulsating vibration air supply port
6
dispersion chamber
10 pulsating vibration air supply conduit
9
0.6MPa
8
7

Fig.5

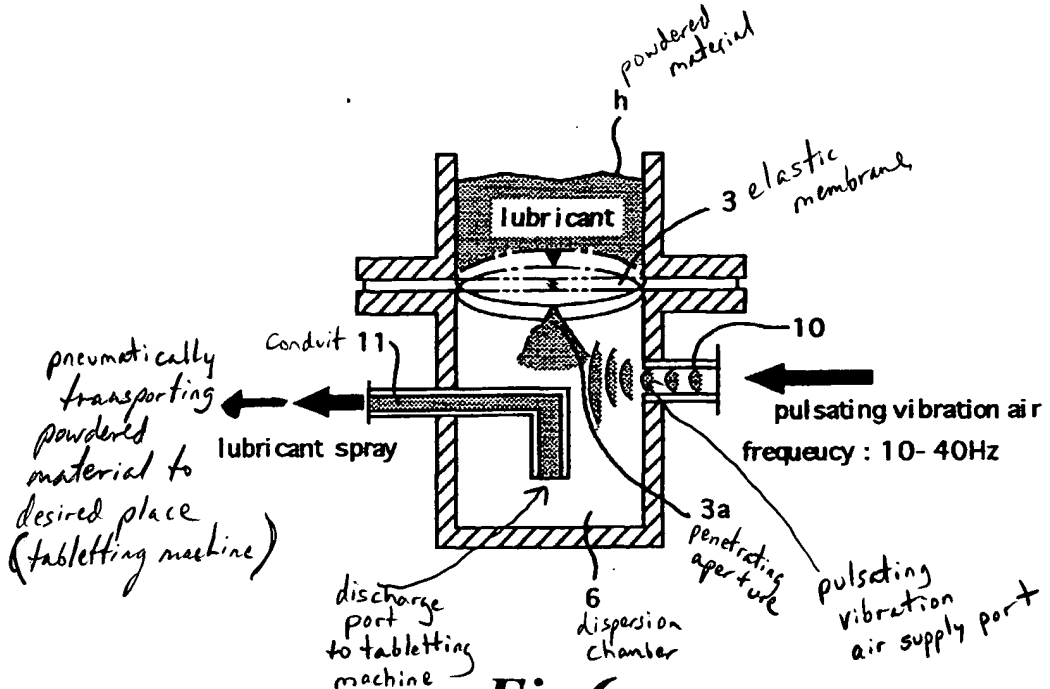
powdered material
h
3 elastic membrane
lubricant
10
Conduit 11
pneumatically transporting powdered material to desired place (tabletting machine)
lubricant spray
pulsating vibration air
frequeucy : 10- 40Hz
3a penetrating aperture
discharge port to tabletting machine
6 dispersion chamber
pulsating vibration air supply port

Fig.6

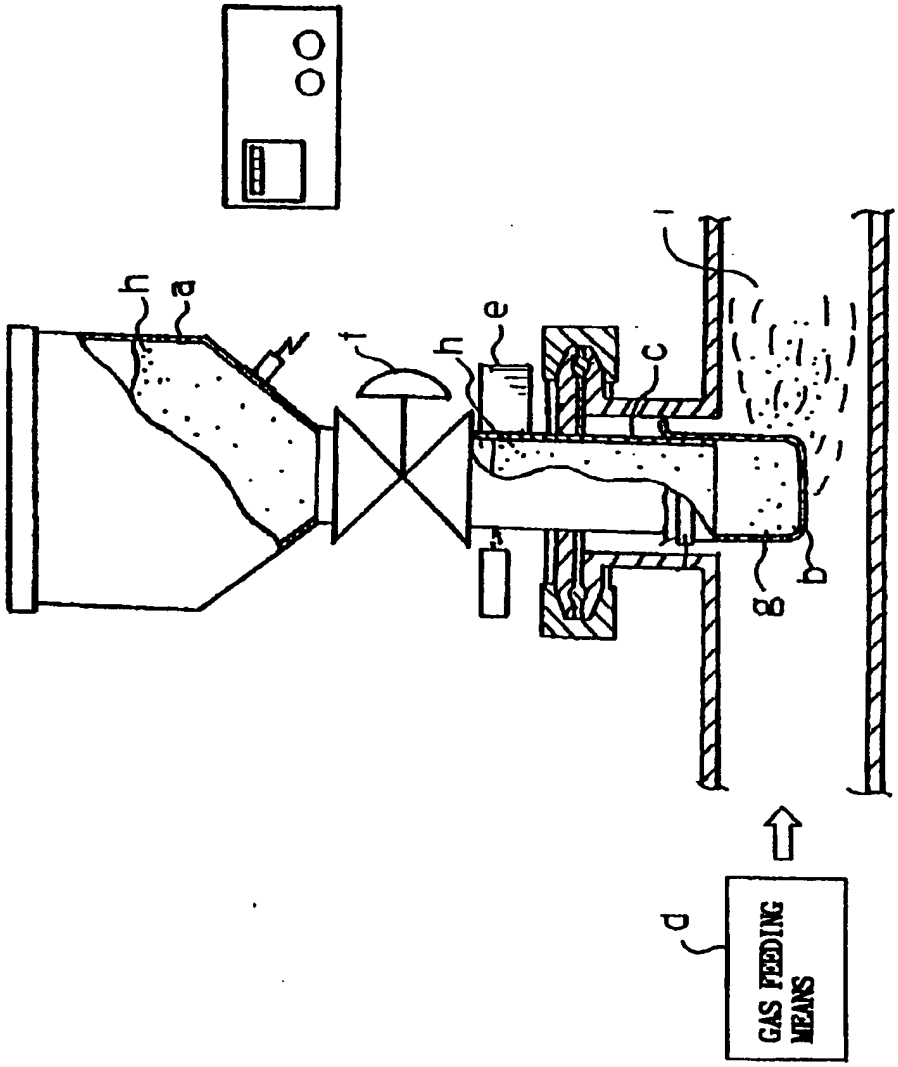

Fig.7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 11 0142

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	FR 2 270 070 A (RAYCHEM CORP) 5 December 1975 * page 5, line 23 - page 9, line 20; figure *	1,4,6	B01J2/00 B05B7/14 B65G53/10
A	US 3 976 332 A (FABEL ARTHUR J) 24 August 1976 * column 2, line 66 - column 5, line 24; figure *	1,4,6	
A	DE 34 18 997 A (GLATT GMBH) 28 November 1985 * page 10 - page 12; figures 7,7A *	1	
A	DE 24 37 856 A (KAYSER LUTZ TILO) 19 February 1976 * page 3 - page 8; figure *	1,2,4,6,7	
A	US 5 332 337 A (WILDE DAVID S ET AL) 26 July 1994 * column 9, line 26 - column 10, line 12; figures 5,6 *	1	
A	US 4 420 279 A (EASLEY JR OTHEL D) 13 December 1983 * column 4, line 53 - column 5, line 16 * * column 9, line 9 - line 31; figures 2,8 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B01J
B05B
B65G
B24C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	16 September 1997	Cubas Alcaraz, J

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